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AIR TRAFFIC CONTROL

FAA's Interim Actions to Reduce Near Mid-Air Collisions

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United States
General Accounting Office
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Resources, Community, and
Economic Development Division

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The Honorable Frank Lautenberg
Chairman, Subcommittee on Transportation
and Related Agencies
Committee on Appropriations
United States Senate

Dear Mr. Chairman:

A mid-air collision, especially one involving a commercial carrier, is a tragic event that fortunately occurs only rarely. In March 1988 you requested that we identify interim measures the Federal Aviation Administration (FAA) could take to reduce the threat of mid-air collisions. You expressed concern about the need to restore public confidence in the air traffic control system and questioned whether FAA was doing all that it could to reduce the threat of mid-air collisions prior to the introduction, in the next decade, of more advanced air traffic control technology such as the Advanced Automation System.

As agreed with your office, we identified (1) where near mid-air collisions (NMAC) involving commercial carriers have been most frequently reported, (2) the short-term safety actions FAA has taken or plans to take to reduce the risk of mid-air collisions involving a commercial carrier, and (3) how FAA uses NMAC data to evaluate the effectiveness of the actions taken. FAA's interim automation efforts will be addressed in another report.[1]

Background

FAA defines a NMAC as either an incident in which the possibility of collision occurs as a result of an aircraft's proximity of less than 500 feet to another aircraft or an official report from an air crew member stating that a collision hazard existed between two or more aircraft. The degree to which NMAC reports can be relied on as an indicator of overall system safety is limited because much of the data is subjective and only those incidents reported are known. FAA investigates each report and categorizes reports as critical, potential, or no hazard. Critical NMACs are incidents in which a collision was avoided only by chance, and include all incidents in which aircraft separation is less than 100 feet. Potential NMACs are incidents that would probably have resulted in a collision if no

[1]The automation issues pertaining to this request are being handled by our Information Management and Technology Division. Its report should be available by mid-summer 1989.

action had been taken by either pilot and usually involve less than 500 feet of separation between aircraft. Critical and potential near-misses are characterized in this report as serious NMACs. NMACs characterized as no hazard occur when direction and altitude would have made a mid-air collision improbable regardless of whether evasive action was taken.

This report focuses on NMACs involving commercial carriers. While all commercial carriers are controlled by FAA air traffic controllers, only those general aviation aircraft flying under instrument flight rules or in specially designated airspace require FAA control. Because FAA can do very little to separate aircraft it is not in communication with, we considered only those NMACs in which FAA was definitely in communication with at least one party.

Results in Brief

We found the following information:

- For calendar years 1986 through 1988, a total of 2,610 NMACs were reported to FAA. Commercial carriers were involved in 1,158 (44 percent) of these reports. Of these, 834 (72 percent) were classified by FAA as serious NMACs. The total number of commercial carrier NMACs reported in 1987 increased substantially compared with 1986, and then declined for 1988. In general, 1986 to 1988 commercial carrier NMACs occurred most often near major airports, while the aircraft are under terminal radar approach control, and involved a general aviation aircraft. The locations with the highest number of commercial carrier NMACs from 1986 to 1988 were Chicago, New York, San Francisco, and Los Angeles, which had almost twice as many incidents as the other locations.
- FAA has implemented many actions to reduce the risk of mid-air collisions in recent years. For example, additional equipment is required on planes, controllers have been provided enhanced hardware and software, and special airspace designations have been made at more airports. However, the future of several promising efforts is uncertain. One effort that would involve NMAC data—establishing a set of safety indicators to identify problem areas—has been delayed because FAA decided to expand the effort and handle it in-house rather than continue to use a contractor. In addition, plans for regional safety offices, which would have analyzed regional NMAC data, have been cancelled because FAA went to a more centralized organizational structure. The Office of Aviation Safety will be responsible for carrying out the work in these areas. However, it is too early to tell what the results of its efforts will be.
- Within the past several years, FAA's attempts to assess the effectiveness of various actions taken by analyzing NMAC data have been met with

mixed success. However, a "before-and-after" analysis of NMACs in and around Los Angeles regulatory airspace successfully showed that NMACs, including incidents between commercial carriers and general aviation aircraft not under air traffic control, decreased after airspace changes were made at that location.

Locations With Highest Number of Reported NMACs and Associated Data Limitations

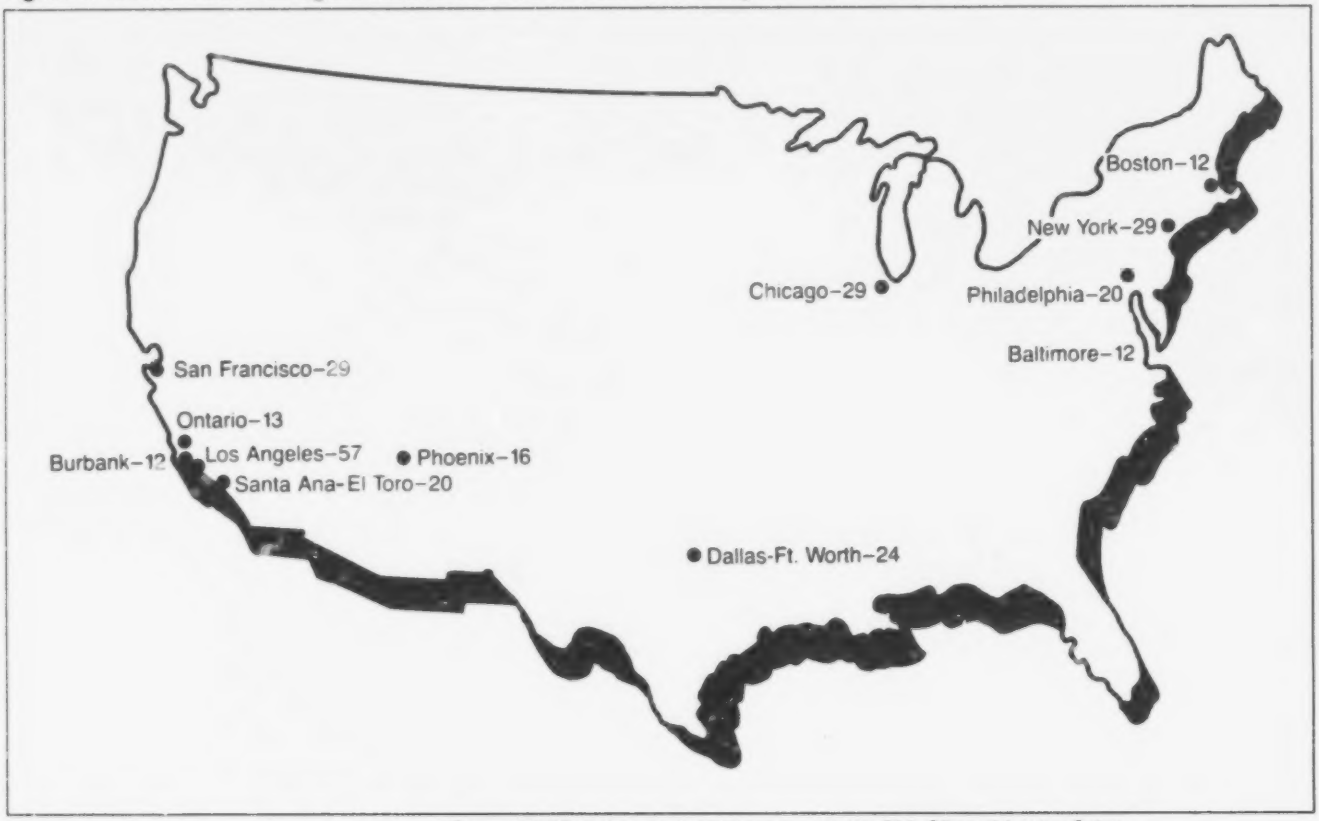
From 1986 through 1988, serious NMACs involving commercial carriers occurred most frequently near major airports, while the carrier was under the direction of an FAA radar approach control facility, and usually involved general aviation aircraft that were not being monitored by air traffic control. The ranking of locations having the highest number of these incidents varied slightly for each of the 3 years. However, Los Angeles had the highest number of these incidents for each of the 3 years, and a 3-year total of almost twice as many serious commercial carrier NMACs as any other location.

FAA's safety statistics show that the number of reported NMACs decreased for calendar year 1988. This could be the result of the safety- and efficiency-related actions FAA implemented prior to and during the 1986 through 1988 time frame. However, because of the limitations associated with NMAC reports, FAA cannot determine how much of the decrease was due to its actions. Furthermore, FAA has not concluded that the drop in reported NMACs reflected an actual decrease in mid-air collision risk.

It bears noting, however, that compared with the number of operations they fly, commercial carriers are involved in relatively few NMACs. In 1988, commercial carriers were involved in a total of 326 reported NMACs in contrast with the 21,875,521 operations they flew.

The following map shows the top 12 "hot spots" for serious commercial carrier NMAC reports in calendar years 1986 through 1988, as well as the number of incidents reported for those locations. (Additional details concerning locations with high numbers of reported NMAC and limitations regarding these reports are provided in apps. II and III, respectively.)

Figure 1: Locations With the Highest Numbers of Serious NMACs Involving Commercial Carriers, 1986-88



Source: NMAC plotting study database provided by FAA, Office of Aviation Safety

FAA Near-Term Efforts to Address the Risk of Mid-Air Collisions

FAA actions to address the mid-air collision threat include implementing improvements to equipment, procedures, and NMAC data collection. Some promising plans to make use of NMAC data, however, have been cancelled or delayed. Examples of implemented and planned actions are the following:

- By the end of 1991, FAA is requiring commercial carrier aircraft with a seating capacity of 30 or more to be equipped with the Traffic Alert and Collision Avoidance System. This system will alert pilots to the presence

of any nearby aircraft equipped with an operating transponder[2] and will recommend avoidance maneuvers to the pilot when necessary. However, a recent study by the Office of Technology Assessment[3] suggests that meeting the installation deadline would strain the resources of the system's manufacturers, airlines, and FAA, jeopardizing necessary aircraft maintenance. FAA agrees with this position.

- FAA is expanding its requirements for two types of transponders to provide controllers with better information. Mode C transponders provide altitude information to controllers and are currently required in relatively few areas. FAA's expanded requirement will make Mode C transponders mandatory in larger areas around the busiest airports effective July 1, 1989, and around moderately busy airports effective December 30, 1990. Mode S transponders, in addition to providing the altitude information of Mode C transponders, provide a unique identification code for each plane, improving the visual identification of aircraft on controller displays. All new transponders installed after January 1, 1992, must meet Mode S transponder requirements.
- FAA's Office of Aviation Safety publishes summaries of NMAC statistics and characteristics. Various entities, such as the Interagency NMAC Working Group, use these data to develop recommendations for reducing NMACs. However, there are indications that the group may be terminated after this year if all their previous recommendations are acted upon. New efforts involving NMAC data have been cancelled or are starting slowly. For example, plans to establish regional safety offices, which were designed to analyze NMAC and other data at the regional level, have been cancelled. Instead, the Office is increasing its headquarters safety staff, in keeping with FAA's new, more centralized organizational structure, to do this type of work. The Office also recently terminated a contract to identify safety trends and build a computer database of safety indicators because management decided to expand the scope of the effort and conduct it in-house. The Office of Aviation Safety is in the process of getting the staff it needs to conduct this work.

(Details on these and other FAA actions to reduce the mid-air collision threat are discussed in app. IV.)

[2]A transponder (transmitter/responder) is a device that electronically responds to an interrogation from ground radar and thereby enhances the equipped aircraft's image on the air traffic controller's radar screen. The Traffic Alert and Collision Avoidance System requires that operating transponders have altitude reporting capability.

[3]Office of Technology Assessment, Safer Skies With TCAS: Traffic Alert and Collision Avoidance System - A Special Report, OTA-SET-431 (Washington, D.C.: U.S. Government Printing Office, Feb. 1989).

FAA's Recent Use of NMAC Data to Assess Safety Action Effectiveness

FAA has used NMAC data in attempts to assess the effectiveness of various safety actions taken. For example, FAA used NMAC data in an attempt to determine (1) how airspace and procedural changes made under the Expanded East Coast Plan to reduce system delays affected safety and (2) whether stronger enforcement penalties for violating regulatory airspace had reduced the number of these incidents. These studies were inconclusive and led FAA's Office of Aviation Safety to recommend that data gathering and maintenance be improved to facilitate future studies. However, a before-and-after analysis of NMACs reported in and around Los Angeles regulatory airspace showed that NMACs had decreased because of actions FAA had taken. The analysis also showed that incident locations had shifted and, of the incidents that did occur, fewer involved commercial carriers.

In early 1988, FAA planned to use NMAC data to determine the effectiveness of keeping commercial carriers at high altitudes for as long as possible to reduce their exposure to the more congested lower altitude airspace surrounding the terminal. However, an FAA official said that this project had not been started as of April 26, 1989. (This FAA policy is known as "Keep 'Em High" and is discussed in greater detail in app. V.)

FAA officials have stated that it is difficult to determine the extent to which a decrease in reported NMACs results from any of FAA's actions. NMACs can fluctuate for a number of reasons, including the recency and notoriety of aviation accidents and pilots' interest in filing NMAC reports. However, FAA's recent successes and plans suggest that NMAC data can still be used to assess the effectiveness of safety actions.

Conclusions

Because the Congress and the flying public expect FAA to ensure safe air travel, the agency must be continually vigilant in assessing safety trends and implementing new safety methods. Recent FAA initiatives regarding safety-related regulations and the analysis and use of NMAC data are encouraging and could contribute to recognizing and reducing mid-air collision threats. However, we found that other initiatives have been disbanded or delayed, and alternate actions are only in the planning stage. Furthermore, the future of an interagency group that reviews NMACs is uncertain.

At this point, it is too early to determine whether FAA's reorganized and expanded Office of Aviation Safety will continue the progress the agency has recently made in analyzing and acting on NMAC data. Therefore, we are not making recommendations at this time. However, we

believe progress in the analysis and use of NMAC data must be sustained, particularly because the Traffic Alert and Collision Avoidance System implementation may now be delayed.

Our work was conducted from May 1988 to March 1989 at FAA headquarters and field locations. (Further details on our objectives, scope, and methodology are provided in app. I.)

We discussed the information in this report with officials in FAA's offices of Air Traffic Operations Service, Flight Standards, and Aviation Safety, and they agreed with the facts. However, as requested by your office, we did not obtain official agency comments on a draft of this report.

As arranged with your office, unless you publicly announce its contents earlier, we will make no further distribution of this report until 15 days after the date of this letter. At that time, we will send copies to the Secretary of Transportation, the Administrator, FAA; interested congressional committees; and other interested parties upon request. Major contributors to the report are listed in appendix VI.

Sincerely yours,

K. M. Mead

Kenneth M. Mead
Director, Transportation Issues

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Abbreviations

ASRS	Aviation Safety Reporting System
FAA	Federal Aviation Administration
FSDO	Flight Standards District Office
GAO	General Accounting Office
NMAC	near mid-air collision
OTA	Office of Technology Assessment
TCA	Terminal Control Area
TCAS	Traffic Alert and Collision Avoidance System
TRACON	Terminal Radar Approach Control Facility

Objectives, Scope, and Methodology

To identify where serious near mid-air collisions (NMAC) involving commercial carriers were most frequently reported over the last 3 years, the near-term safety actions proposed or taken by the Federal Aviation Administration (FAA) to address them, and how the agency assessed the effectiveness of its actions, we interviewed responsible officials in FAA's offices of Air Traffic Operations Service, Flight Standards, and Aviation Safety at FAA headquarters in Washington, D.C.

At these offices we obtained and reviewed documentation regarding FAA policies on the reporting, investigation, and analysis of NMAC data, as well as NMAC reports, computer data, and statistical information. We used the data from recent studies performed on NMAC data by or for FAA to identify serious commercial NMAC "hot spots." We did not test or verify the reliability of the data, and the numbers presented in this report are FAA's.

FAA is still compiling the 1988 NMAC statistics. Data regarding the locations of NMACs are from the plotting studies being completed for the Office of Aviation Safety as of March 15, 1989. All other NMAC data in the report is as of April 4, 1989.

We used the information regarding NMAC hot spots as the basis for selecting our field audit work locations. We conducted the field work to determine the extent to which, and how, NMAC information influenced operations at those locations. Specific field locations we visited were FAA's

- Eastern Regional Office, New York Terminal Radar Approach Control Facility (TRACON), and Flight Standards District Office (FSDO) #25,
- Southwest Regional Office, Dallas-Ft. Worth TRACON, and Dallas-Ft. Worth FSDO #60,
- Great Lakes Regional Office, Chicago TRACON, General Aviation District Office #3, Air Carrier District Office #31, and
- Western-Pacific Regional Office, Los Angeles TRACON, and FSDO #10.

We obtained information regarding actions proposed to and/or taken by FAA regarding NMACs by interviewing and obtaining documentation from FAA, the National Transportation Safety Board, and National Aeronautics and Space Administration officials. We also conducted a literature search to identify other studies performed regarding NMACs, and obtained the views of officials from the Office of Technology Assessment, Air Transport Association, Air Line Pilots Association, Regional

Airline Association, National Business Aircraft Association, and Aircraft Owners and Pilots Association, regarding the NMAC issue.

Our review was conducted between May 1988 and May 1989 and adhered to generally accepted government auditing standards.

Locations of Serious NMACs Involving Commercial Carriers, Calendar Years 1986 Through 1988

Of the 2,610 NMACs reported to FAA for calendar years 1986 through 1988, commercial carriers were involved in 1,158. FAA categorized 834 of the commercial carrier incidents as serious (critical or potential) mid-air collision threats. Table II.1 shows the total number of reported NMACs, the number involving commercial carriers, and the number of commercial carrier NMACs considered serious, for each of the 3 years.

Table II.1: Serious NMACs Involving Commercial Carriers, 1986-88

Calendar year	Total NMACs reported	Commercial carrier NMACs	Serious commerical carrier NMACs
1986	840	343	249
1987	1,058	489	354
1988	712	326[a]	231[a]
Total	**2,610**	**1,158**	**834**

[a]As of April 4, 1989, FAA had not completed classification of all calendar year 1988 NMACs and these categories may vary by a very small percentage.

FAA Plotting Studies Identify NMAC "Hot Spots"

FAA had a contractor plot the locations of NMACs reported for each of the 3 calendar years. The studies show where the reported NMACs occurred in relation to various types of regulatory airspace, or hubs. A hub is defined as all the airspace within a 40-nautical-mile radius of a primary facility and up to 12,500 feet above ground level. A primary facility is the airport of the most-likely controlling radar facility associated with the NMAC. When there is no radar facility, the primary facility may be a towered or non-towered airport. The hub concept is used by FAA to provide comparable airspaces of equivalent volume.

Data from these studies show that serious NMACs involving commercial carriers reported for calendar years 1986 through 1988 occurred most frequently near major airports. Specific NMAC "hot spots" for these years are the hubs associated with Los Angeles, San Francisco, metropolitan New York, Chicago, and Dallas-Ft. Worth. Of these locations, a higher number of serious commercial carrier NMACs were reported for Los Angeles in each of the 3 years. Table II.2 shows the 12 hubs where serious NMACs involving commercial carriers were most frequently reported (based on a 3-year total count) for calendar years 1986, 1987, and 1988.

Table II.2: Locations With Highest Numbers of Serious NMACs Involving Commercial Carriers, 1986-88

Location	Calendar year 1986	1987	1988[a]	Total
Los Angeles, CA	19	26	12	**57**
Chicago, IL	15	9	5	**29**
New York, NY	8	15	6	**29**
San Francisco, CA	7	11	11	**29**
Dallas-Ft. Worth, TX	7	10	7	**24**
Philadelphia, PA	3	13	4	**20**
Santa Ana-El Toro, CA	7	10	3	**20**
Phoenix, AZ	6	4	6	**16**
Ontario, CA	6	2	5	**13**
Baltimore, MD	2	7	3	**12**
Boston, MA	4	6	2	**12**
Burbank, CA	5	4	3	**12**
Total	**89**	**117**	**67**	**273**

[a]As of March 15, 1989, FAA had not completed plotting all the calendar year 1988 NMACs

On a regional basis, FAA's Western-Pacific, Eastern, Southern, and Great Lakes regions had relatively high numbers of serious commercial carrier NMACs for 1986 through 1988.

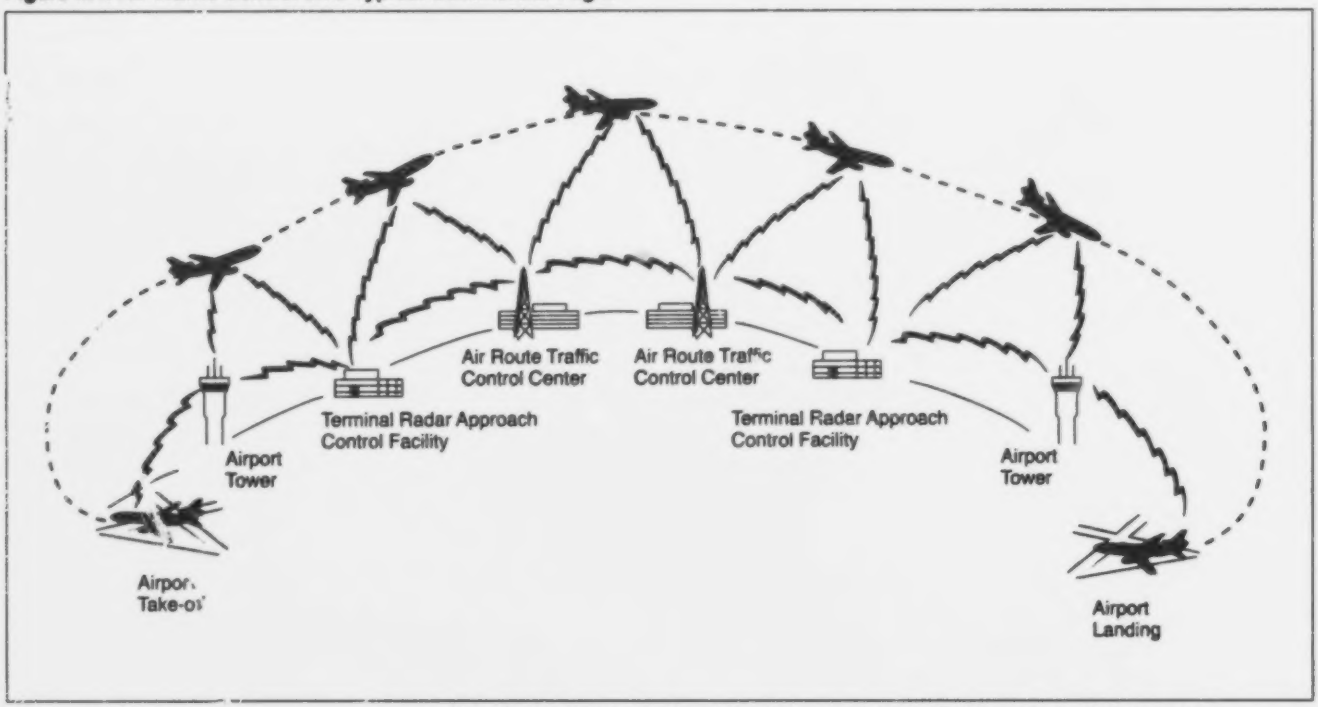
The plotting studies show that high levels of traffic do not necessarily mean high levels of NMACs. For instance, although Atlanta-Hartsfield is one of the two busiest airport hubs in the nation, no more than four serious commercial carrier NMACs were reported in airspace associated with that airport in any of the 3 years.

General Characteristics of NMACs

FAA's data show that most reported NMACs occur (1) between an aircraft flying under instrument flight rules and one flying under visual flight rules, (2) when visibility is good, and (3) at an altitude of 1,001 to 5,000 feet. Most NMACs do not involve a violation of the Federal Aviation Regulations or an operational error on the part of a controller.

Most serious NMACs involving a commercial carrier from 1986 to 1988 occurred when the aircraft was under the control of a terminal radar approach control facility (radar control). A terminal radar approach control facility is one of several types of air traffic control that commercial carriers are typically under during the course of flight. (See fig. II.1.)

Figure II.1: Air Traffic Control on a Typical Commercial Flight



Note: An airport tower and terminal radar approach control facility can be located separately or together.

Table II.3 shows the type of air traffic control that commercial carriers were under when serious NMACs took place from 1986 to 1988.

Table II.3: Type of Air Traffic Control the Commercial Carriers Were Under When Serious NMACs Occurred

Calendar year	Radar	Center	Tower	Other	None	Unknown	Not reported
1986	121	45	50	16	16	1	0
1987	167	62	87	14	18	3	3
1988[a]	108	49	43	14	13	4	0
Total	**396**	**156**	**180**	**44**	**47**	**8**	**3**

[a]As of April 4, 1989, FAA had not completed classification of all the calendar year 1988 NMACs.

Relatively few serious commercial carrier NMACs involve military aircraft or two commercial carriers. Of the serious NMACs involving commercial carriers in 1986, 1987, and 1988, military aircraft were involved in 26, 34, and 27 of these incidents, respectively. Only 28 of the serious

NMACs in 1986, 30 in 1987, and 15 in 1988 involved two commercial carriers. Most commercial carrier NMACs occur with general aviation aircraft.

NMAC Data Limitations

Two reporting systems exist under which NMAC incidents may be reported. One system is maintained by FAA, and the other system, known as the Aviation Safety Reporting System (ASRS), is maintained for FAA by the National Aeronautics and Space Administration. NMACs may be reported to either or both systems. The "companion" ASRS was established because of concern that fear of punitive action was limiting the number of NMACs reported to FAA. (NMAC reports made to FAA can result in enforcement actions if they involve violations of FAA regulations.) Pilots who report to ASRS are granted limited immunity from FAA enforcement action, and their identities are intentionally obscured. We used FAA, rather than ASRS, data in this report, however, because (1) ASRS reports are not independently investigated and (2) ASRS does not include NMAC reports from military sources. FAA's database does not have these limitations.

The data in both systems have a number of shortcomings. Most arise from the voluntary nature of the reporting process and the subjective factors on which the decision to report is based. These deficiencies limit the extent to which NMAC data can be relied on as an overall indicator of system safety. However, analysis of these encounters, particularly with regard to the airspace and geographic locations in which they occur, can provide information useful in formulating and assessing remedial actions.

NMAC Reporting Is Voluntary and Subjective

NMAC reports are voluntarily filed by a pilot or flight crew member of commercial, military, or general aviation aircraft. Essentially, a NMAC report is a written account of a pilot or flight crew member's perception that while in flight, another aircraft came dangerously close and a potential for collision existed.

The number of NMACs reported each year can be influenced by factors not easily quantified, such as heightened awareness caused by the recency and notoriety of aviation accidents such as mid-air collisions, the media attention given aviation safety-related subjects, special interest group and pilot association influences, and reactions to FAA regulatory proposals. For example, FAA cited publicity surrounding the mid-air collision over Cerritos, California, and reaction to proposed additional regulation as two of several possible additional factors that influenced NMAC reporting in calendar year 1986.

There is now no way of telling how many NMACs actually occur each year—only those reported are known. A pilot or flight crew member

may decide not to file a NMAC report to FAA when a violation of FAA regulations is involved because penalties could be assessed to them or others. Some NMACs can also go undetected by pilots and flight crews for many reasons, including (1) preoccupation with cockpit requirements, (2) visibility obscured by cloud cover, (3) approach angles, and (4) restricted view because of cockpit or aircraft design. On the other hand, a NMAC may be reported even though the other aircraft was identified to the pilot by the air traffic controller and the pilot had the traffic in sight at all times. The decision to report a NMAC and the accuracy with which encounter circumstances and miss distances are described can also be affected by factors such as (1) the pilot's experience level, (2) the pilot's attitude regarding what constitutes safe separation, (3) the element of surprise (fear) caused by the encounter, and (4) the relative sizes and speeds of the aircraft involved. Some NMAC reports are subsequently found to have presented no mid-air collision threat. However, all incidents reported to FAA are included in yearly NMAC totals.

NMAC Data Verification/ Investigation

Several pieces of information are gathered by the air traffic control facility when an aircraft under its control is involved in a NMAC. This information includes statements from the pilot and/or crew, voice tapes of pilot and controller communications, controller statements, and radar plots (when available). The FAA facility reviews this data to determine whether controller error caused or contributed to the NMAC, and whether the presence of the other aircraft was noted and pointed out to the pilot by an air traffic controller. This information is sent for investigation by the appropriate flight standards district office with geographic responsibility for the location in which the NMAC was reported to have occurred.

Some FAA officials maintain that the primary function of the NMAC investigation is to identify the characteristics of the incident and develop corrective actions to prevent future occurrences. Others believe the primary purpose is determining whether pilot error caused the incident and whether any FAA regulations were violated. Information from the final investigation can be used as evidence in enforcement action hearings. Final investigation reports are also used to update information in the FAA headquarters NMAC database.

As part of the NMAC investigation, the inspector determines whether the miss distances involved presented a critical, potential, or nonexistent (no hazard) mid-air collision threat. Verification of actual miss distances involved eliminates uncertainty as to whether a serious mid-air collision

threat was present. In this regard, FAA requires that air traffic control facilities provide data reduction plots of the involved aircrafts' courses for NMAC incidents that take place in their airspace. However, this information is not always available for several reasons. Often the other aircraft involved does not have an operating transponder or one with altitude reporting capability. As such, the incident might not appear on air traffic radar tapes, and if it does, altitude information is not provided. Sometimes no identifying information is available regarding the other aircraft and the inspector is never able to establish its identity.

In addition, FAA's radar approach control facilities do not always provide radar plots of the NMAC incidents that occur in their airspace, even if it would otherwise be available. For instance, the New York and Los Angeles radar approach control facilities provide radar plots only when specifically requested to do so. Because of computer capacity limitations, the Chicago-O'Hare radar approach control facility cannot provide radar plots of the NMACs reported in its airspace at all.

FAA's Interim Actions to Improve Safety and Reduce the Risk of Mid-Air Collisions

FAA has taken and planned a variety of actions related to NMACs in the past few years. We consider these to be interim actions to address NMACs until improvements, such as the Advanced Automation System, are in place. FAA's interim actions relate to (1) equipment required on planes, (2) equipment and software for controllers, (3) airspace, (4) air traffic control procedures, (5) enforcement of FAA regulations, and (6) training for pilots and controllers. FAA also initiated various studies and groups to consider safety indicators, including NMACs, but these efforts are evolving as the Office of Aviation Safety finalizes its new organizational structure and goals. The following sections discuss FAA's interim actions.

Equipment Required on Planes

Public Law 100-223 requires that civilian planes carrying over 30 passengers be equipped with the Traffic Alert and Collision Avoidance System (TCAS) after December 30, 1991. TCAS is an airborne warning system that alerts pilots to conflicting traffic and advises them how to avoid it. TCAS II will be the first of three TCAS versions to go into operation. TCAS II provides pilots with vertical avoidance maneuvers. Airline tests since 1987 indicate the system is successful in helping pilots locate nearby aircraft and substantially enhances air traffic safety. FAA is developing the more advanced TCAS III, which will add horizontal avoidance maneuvers. TCAS I, the least costly and simplest of all TCAS versions, will be required on smaller commuter planes by 1995.

Questions about whether TCAS II can be fully implemented by 1991 led to an Office of Technology Assessment (OTA) report on the readiness of the aviation industry for the system.[1] The report concluded that meeting the deadline will strain the resources of TCAS manufacturers, airlines, and FAA. OTA expressed concern that critical airline maintenance and modification programs could suffer as a result of the required schedule. OTA believes a phased implementation of TCAS II should be considered, and FAA agrees. Extending the deadline for implementation by 1 or 2 years was the subject of a recent congressional hearing. In our opinion, the possible delay in the full implementation of TCAS II makes FAA's other interim efforts to reduce the mid-air collision risk in the meantime more important than ever.

[1] Safer Skies With TCAS: Traffic Alert and Collision Avoidance System - A Special Report (OTA-SET-431, Feb. 1989).

In addition to TCAS, FAA is requiring the Mode C transponder and the Mode S beacon system on planes as aids in collision avoidance. Through rulemaking, FAA has established requirements for the Mode C transponder, which conveys aircraft altitudes to air traffic controllers, enhancing controllers' ability to separate traffic. It will be required for flying around the busiest airports and above 10,000 feet by July 1989 and for flight near moderately busy airports by 1991. Another rule establishes a phased transition from the existing air traffic control radar beacon system to the Mode S beacon system. The Mode S beacon system will improve aircraft location and identification information and prevent garbled replies from adjacent aircraft. FAA will limit the manufacture and installation of the older radar beacon system and require that all new transponders installed after January 1, 1992, meet Mode S standards.

On December 2, 1985, FAA also issued a rule requiring any aircraft equipped with an operable transponder to have it turned on while operating in controlled airspace. The "transponder-on" rule is intended to enhance aviation safety by providing increased aircraft target visibility to controllers.

New Equipment and Software for Controllers

Improvements for air traffic controllers include the Mode C Intruder[2] software. This feature gives controllers an alert when two planes with Mode C transponders, controlled or uncontrolled, are in a potentially hazardous situation. Because use of the Mode C Intruder software necessitates additional computer capacity, FAA has initially implemented the feature on the new computer systems located at the 20 air route traffic control centers. The computer at the New York TRACON has been recently upgraded and the remainder of the TRACONs will receive their hardware upgrades in the early 1990s. The TRACONs will receive Mode C Intruder software in the early 1990s.

However, the Mode C Intruder software could exceed the capacity of both the controllers to deal with the information and the terminal computers to process it. FAA officials believe that the feature will be helpful as long as controllers do not become overloaded by the traffic alerts it generates. Their concern is based on agency experience with another software program called conflict alert. This software advises controllers

[2]Federal Aviation Regulations (FAR 91.90) require appropriate authorization from air traffic control prior to the operation of an aircraft in Terminal Control Area (TCA) airspace. An aircraft entering a TCA without this authorization is considered an intruder.

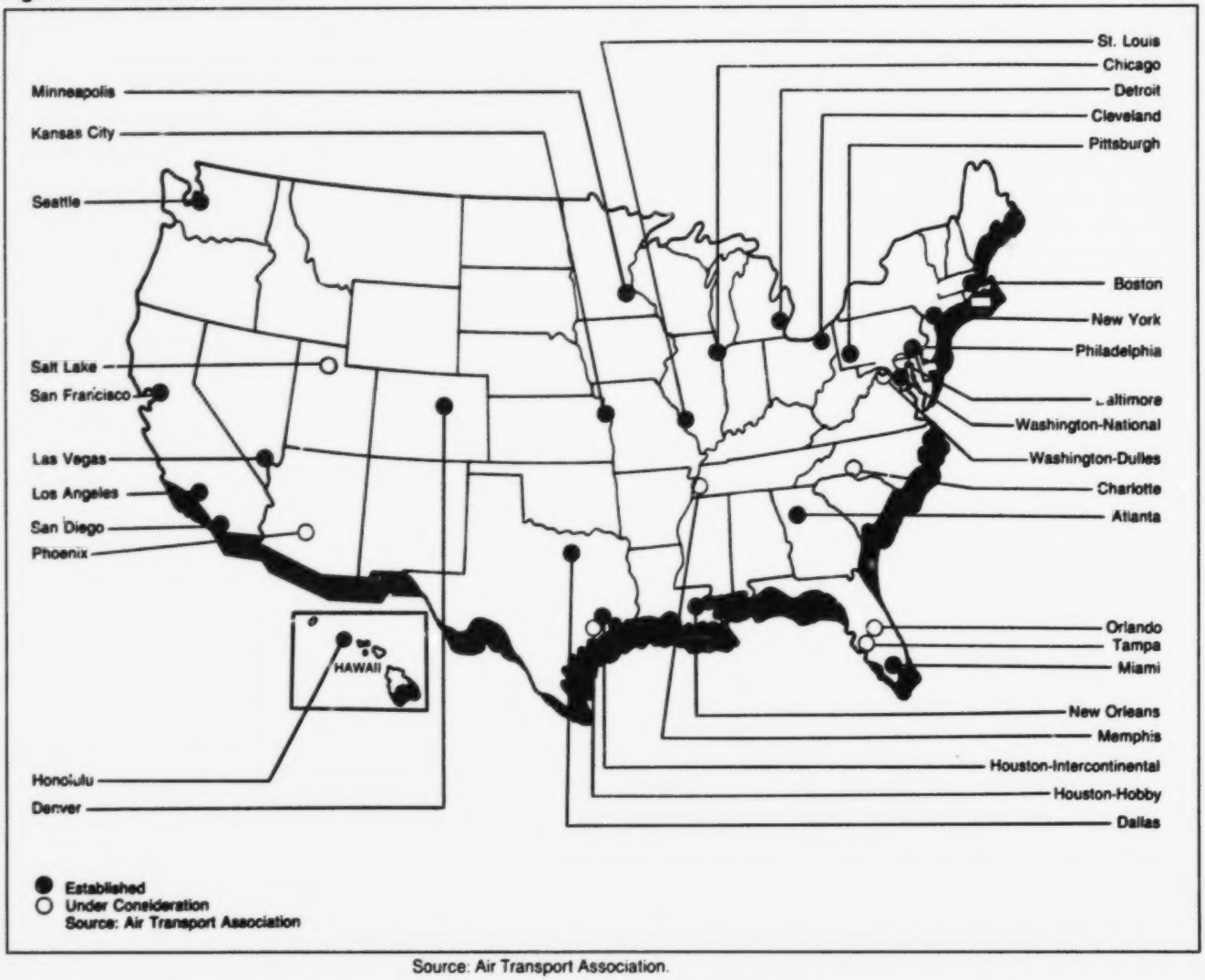
when two aircraft with Mode C transponders will violate separation standards within a 2-minute interval. Because of numerous instances of false alarms, controllers have momentarily suppressed the conflict alert system when confronted with too many such advisories. In addition, FAA officials believe computer capacity upgrades at terminal facilities may not be sufficient. These upgrades must provide enough capacity not only for the Mode C intruder software but also for processing additional altitude information generated by the new Mode C requirement.

In August 1986 Cerritos, California, was the scene of a mid-air collision between a commercial carrier and a general aviation aircraft that had entered Los Angeles regulatory airspace without clearance. The general aviation aircraft was not under air traffic control and was not equipped with an altitude reporting transponder. Among several safety initiatives taken subsequently by FAA, the agency has begun testing a new type of radar capable of determining aircraft altitude without the use of a transponder. This radar was tested in the Los Angeles area. Through additional testing, FAA will ascertain whether more units should be acquired for other locations.

Airspace Changes

FAA has made several changes related to airspace in its efforts to reduce the risk of collisions. Around high-density traffic airports, Terminal Control Areas were established to provide areas in which all aircraft are subject to specific operating rules and equipment requirements. FAA lowered the criteria necessary for a TCA to be established at an airport. The previous criteria were 3.5 million passengers per year and 300,000 instrument operations, of which 60 percent must be commercial carrier operations. The new criteria is 3.5 million passengers per year or 300,000 instrument operations, of which 50 percent must be commercial carrier operations. Currently, there are 23 TCAs nationwide and 9 more are under consideration. (See fig. IV.1.)

Figure IV.1: Locations of TCAs



Source: Air Transport Association.

The TCA Task Group Review was convened as a result of the mid-air collision in Cerritos, California. Several improvements have been made to TCAs on the basis of the task group's 39 recommendations. The improvements include a final rule, effective January 12, 1989, replacing the three types of TCAs with a single type. FAA further standardized and

simplified TCAs by developing new TCA design criteria. The design criteria address the horizontal and vertical limits of TCAs. Around moderately busy airports, FAA is replacing the terminal radar service areas with a system designed to be more efficient—the airport radar service area. FAA has established 125 of these facilities and has more scheduled.

FAA also raised the top of the Los Angeles TCA in 1987 and established two visual flight rules transition routes through the TCA in 1988. Transition routes are charted on navigational maps as a means for visual flight rules planes to go through the TCA. A study by FAA's Office of Aviation Safety shows that the changes were effective in lowering the number of NMACs in the area, particularly those involving commercial carriers. An action notice sent to all regional air traffic offices required them to evaluate their TCAs to determine whether visual flight rules transit routes were warranted and to establish them where possible. However, the regional offices did not establish any additional routes. Headquarters also encouraged regional offices to establish flyways for aircraft flying under visual flight rules. Flyways are suggested routings for pilots to avoid TCAs and are not charted on navigational maps. Flyways have been established in Atlanta, Dallas-Fort Worth, Miami, Houston, Los Angeles, and San Diego.

Additionally, FAA has some airspace changes in the planning phase. FAA plans to propose a rule that would lower the common floor for controlled airspace over the United States from 14,500 to 1,200 feet. FAA believes that most of the U.S. airspace at or above 1,200 feet is already controlled airspace through various regulatory designations such as transition area or federal airway. The lower floor for controlled airspace would increase minimum visibility requirements for visual flight rules operations from 1 to 3 miles, allowing fewer planes to fly in poor weather.

Air Traffic Control Procedures

To further improve safety, FAA enhanced its air traffic control procedures. A 1986 FAA order directed controllers to keep high-performance aircraft flying as high as possible for as long as possible to reduce their exposure to the congested low-altitude terminal environment. The Interagency NMAC Working Group endorsed the procedure, known as "Keep 'Em High," and called for expanded use. However, various aviation trade associations have recently expressed concern that FAA was no longer adhering to this procedure. (Additional details on this procedure are provided in app. V.)

FAA also standardized procedures for tracking TCA intruder aircraft between adjacent air traffic control facilities and sectors. This was intended to improve identification of aircraft and pilots involved so that violations could be referred for enforcement action.

Enforcement of FAA Regulations and Training for Pilots and Controllers

FAA's enforcement policy regarding unauthorized aircraft intrusions into TCA airspace was made more stringent in response to the Cerritos mid-air collision. In the 10 years before the mid-air collision, enforcement actions for violating the Federal Aviation Regulations regarding TCAs were primarily administrative--FAA issued warning letters. Shortly after the Cerritos accident, FAA implemented the following enforcement policy for cases of TCA violations: (1) administrative action should not be used, (2) suspension of airman certificates should be no less than 60 days, (3) civil penalties should be used only where suspension is precluded or if it would be more of a deterrent, and (4) the maximum statutory penalty of $1,000 must be sought.

Headquarters has also initiated educational programs such as "Back to Basics" and "Call to Action". The Back to Basics program refreshes general aviation pilots and controllers on fundamental operating procedures. Call to Action is a joint FAA/industry effort to improve pilot/controller communications. Regional and field facilities have their own training efforts, including the distribution of a TCA Avoidance Guide to general aviation pilots from the Eastern Regional Office and visits by Dallas-Fort Worth controllers to commercial carrier pilot lounges to exchange ideas on improving operations.

NMAC Data Collection, Analysis, and Use

FAA's Office of Aviation Safety compiles all NMAC reports in a database and publishes monthly and quarterly statistical profiles of the data. A new NMAC reporting form is being developed to provide more information on each incident, particularly causal information. Office of Aviation Safety and National Aeronautics and Space Administration ASRS staff have periodic conference calls to share information on the NMACs reported to their agencies. In addition, the Office of Aviation Safety has conducted or commissioned studies of various aspects of NMACs. These include identifying where NMAC incidents are highest, exploring the relationships between NMACs and actual mid-air collisions, and determining the characteristics of NMACs occurring under visual versus instrument flight rules.

FAA also established or planned several long-term efforts to address NMACs. These are (1) the Interagency Near Mid-Air Collision Working Group, (2) the regional Programs for Safety and System Capacity, and (3) a study of safety indicators, including NMACs.

Since 1986, the Interagency Near Mid-Air Collision Working Group has met five times to review NMAC data and develop recommendations to address the incidents. The Working Group includes representatives from FAA, the Department of Defense, National Aeronautics and Space Administration, and the National Transportation Safety Board. The Working Group has made 17 recommendations to FAA, 6 of which FAA is still in the process of addressing. Implemented recommendations include requiring Mode C transponders on aircraft, expediting the transition to airport radar service areas, and accelerating the development and installation of TCAS. Recommendations FAA is in the process of addressing include placing greater emphasis on collision avoidance techniques in flight training and developing radar scanning procedures for controllers. The 1989 meeting will determine whether further meetings of the Working Group are needed. The current chairman said that no definitive plans have been made concerning future Working Group activities. He also said that the group should be disbanded if NMACs continue to decline and no further recommendations are made or remain outstanding. Other FAA managers indicated that no decision had been made to disband the Working Group. Therefore, it is uncertain whether this group will continue to function beyond the next meeting.

Starting in 1985, FAA tested a program for safety and system capacity in FAA's Eastern Region. Staff analyzed the region's safety indicators, such as NMAC reports, and ensured that corrective actions were implemented when necessary. Because of the program's success, the Associate Administrator of Aviation Safety approved establishing similar programs in all regions. However, the Eastern Region program was disbanded in December 1988 as a result of FAA's "straightline" reorganization. Straightlining increased regional offices' accountability to headquarters. The Office of Aviation Safety did not remove the regional offices from its organizational plans until recently, however, when FAA management found that the Office's request for regional safety programs was not adequately justified. The Office instead received 20 additional staff positions to handle safety functions at the headquarters level.

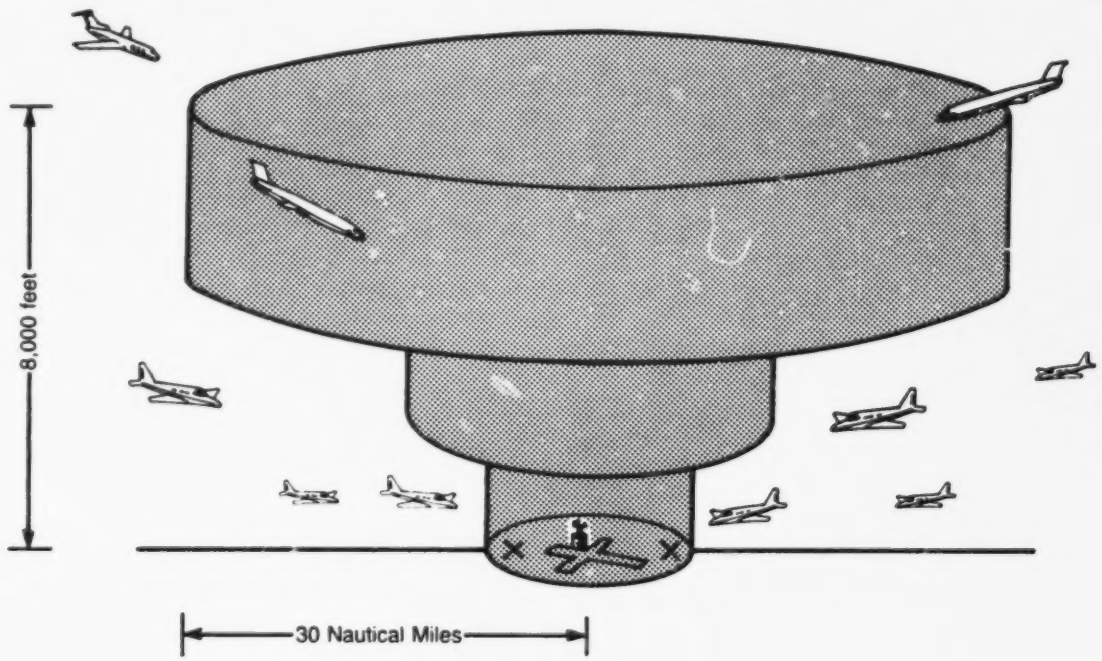
In response to recommendations by the Senate Committee on Appropriations, OTA, and GAO, FAA initiated the development of a system to identify

and address safety trends. FAA hired a contractor in 1988 to complete a two-part study by 1992. The first part was to focus on air traffic safety indicators and the second part was to address flight operations safety indicators. According to an FAA official, the contract was cancelled in January 1989 because of inadequate funding and identification of additional requirements that were not included in the contract. The Office of Aviation Safety has now established a division to manage the effort in-house. However, the division is not yet fully staffed.

Implementation of FAA's "Keep 'Em High" Policy

In September 1986, FAA amended and reissued an air traffic control procedure for commercial carriers called "Keep 'Em High." Basically, this procedure keeps high-performance commercial carrier aircraft at altitudes above 5,000 feet for as long as possible before they descend into the regulatory airspace surrounding their destinations, and ensures that on departure they climb to altitudes above 5,000 feet as fast as is practical. This policy is intended to reduce noise, promote fuel conservation (it takes less fuel to fly at higher altitudes), and reduce the risk of mid-air collision. Figure V.1 shows the typical profile of regulatory airspace.

Figure V.1: Regulatory Airspace



Note: Shaded area is regulatory airspace. Actual shapes and sizes vary by type of regulatory airspace and specific location. Only aircraft under FAA air traffic control are permitted to enter.

Source: FAA.

General aviation aircraft can become dense around regulatory airspace borders as these aircraft circle, awaiting clearance to enter, and/or

attempt to circumnavigate the regulatory airspace perimeter. In addition, many general aviation airports lie under or within regulatory airspace borders. FAA's data show that most of the NMACs reported for calendar years 1986 through 1988 occurred at altitudes of 5,000 feet and below, and in and around regulatory airspace under the coverage of a terminal radar approach control facility. Most of these incidents also involved general aviation aircraft flying under visual flight rules and not under FAA air traffic control at the time.

Given the facts and diagram of figure V.1, if commercial carriers descend and climb through the top and within the borders of regulatory airspace, this would tend to reduce the potential for a NMAC. Conversely, to the extent commercial carriers descend or climb through the sides of regulatory airspace at altitudes of 5,000 feet or below, NMAC potential would increase.

FAA's Office of Air Traffic Operations Service planned to evaluate the application of the "Keep 'Em High" policy at terminal facilities in 1988. However, FAA had not completed the evaluation at the time of our review. The plotting of commercial carrier NMACs by specific regulatory airspace (i.e., Los Angeles TCA, New York TCA, etc.) and altitude location could offer an alternative means by which to evaluate whether associated radar facilities are having difficulty adhering to the "Keep 'Em High" policy.

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